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Manning

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(54) **APPARATUSES AND METHODS FOR PERFORMING COMPARE OPERATIONS USING SENSING CIRCUITRY**

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CPC *G11C 7/06* (2013.01); *G11C 7/062* (2013.01); *G11C 7/10* (2013.01); *G11C 7/1006* (2013.01); *G11C 7/1048* (2013.01); *G11C 7/12* (2013.01); *G11C 11/4091* (2013.01); *G11C 11/4096* (2013.01)

(58) **Field of Classification Search**
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See application file for complete search history.

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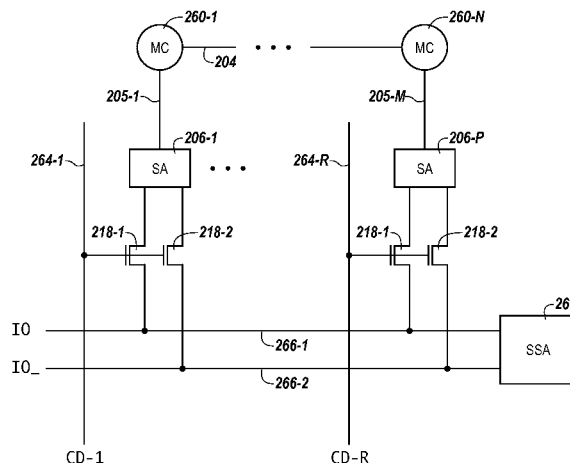
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(57) **ABSTRACT**

The present disclosure includes apparatuses and methods related to performing compare and/or report operations using sensing circuitry. An example method can include charging an input/output (IO) line of a memory array to a voltage. The method can include determining whether data stored in the memory array matches a compare value. The determination of whether data stored matches a compare value can include activating a number of access lines of the memory array. The determination can include sensing a number of memory cells coupled to the number of access lines. The determination can include sensing whether the voltage of the IO line changes in response to activation of selected decode lines corresponding to the number of memory cells.

20 Claims, 4 Drawing Sheets

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  G11C 11/4096 (2006.01)

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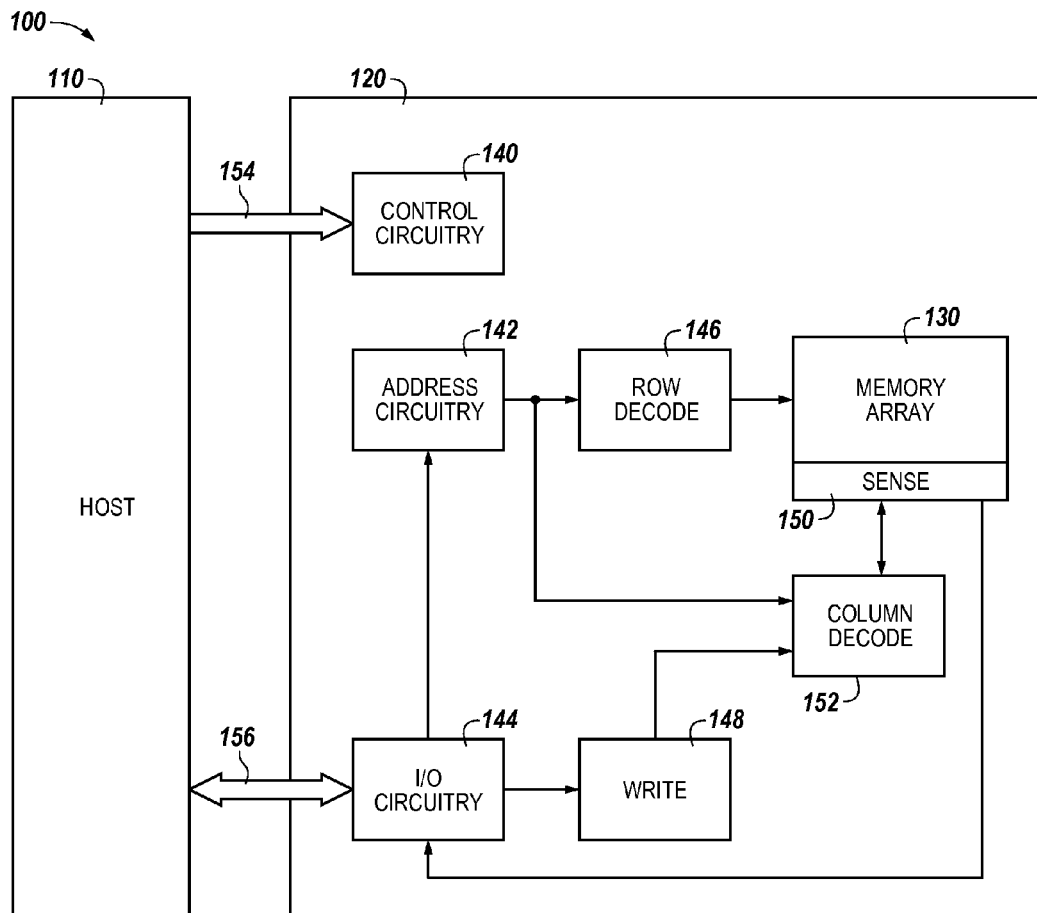
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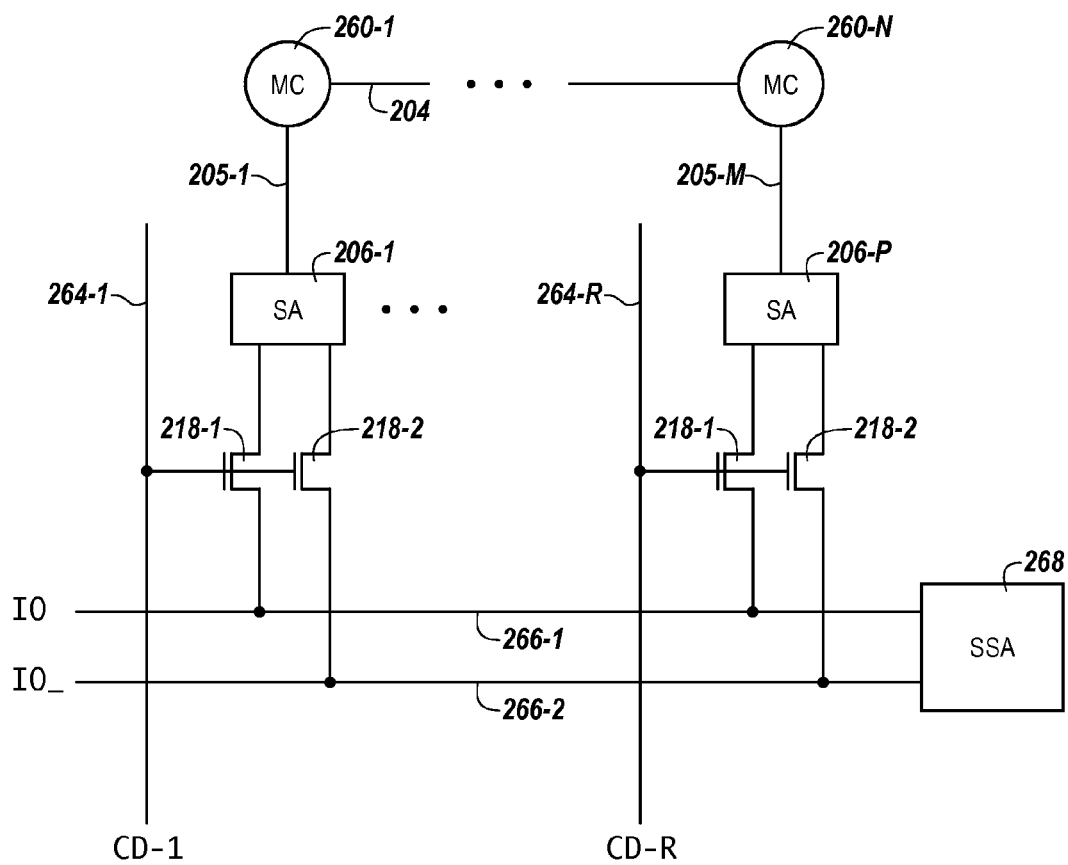
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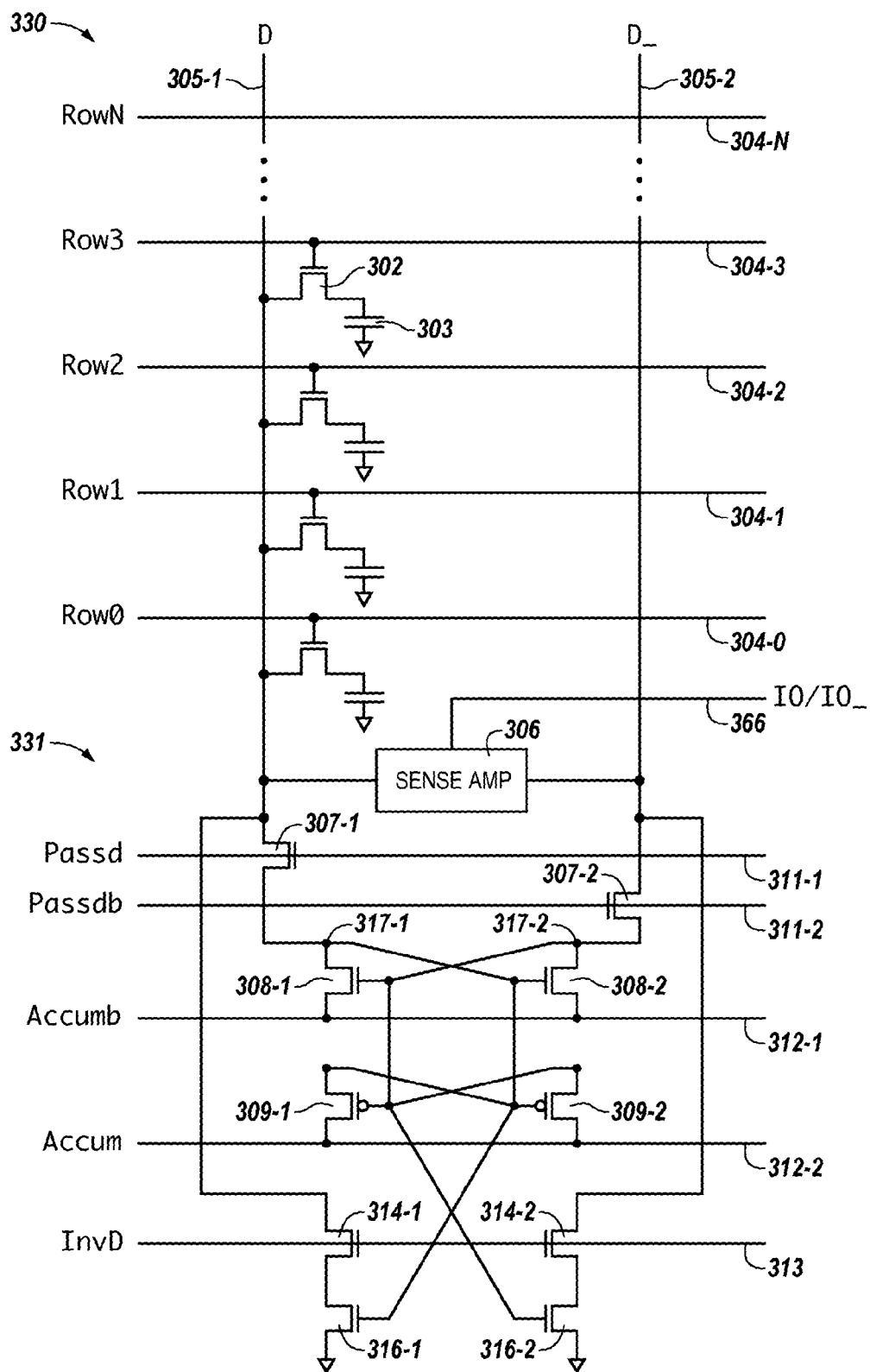
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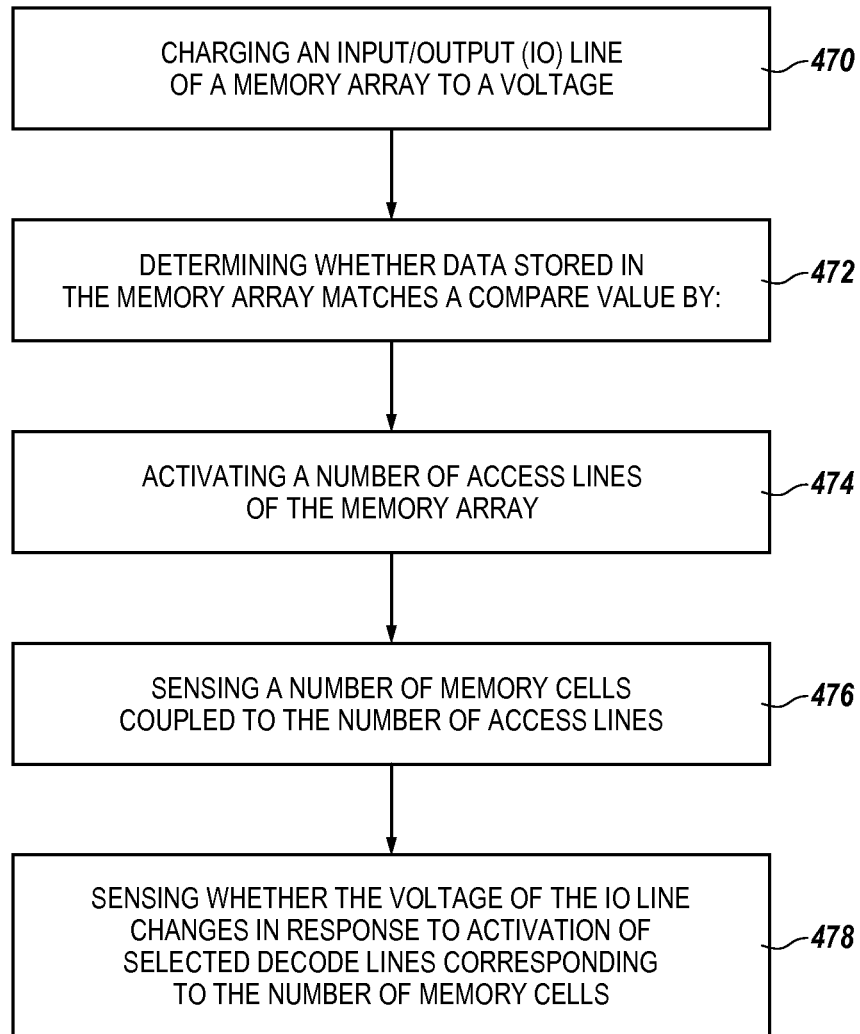
CHARGING AN INPUT/OUTPUT (IO) LINE
OF A MEMORY ARRAY TO A VOLTAGE — 470

↓

DETERMINING WHETHER DATA STORED IN
THE MEMORY ARRAY MATCHES A COMPARE VALUE BY: — 472

↓

ACTIVATING A NUMBER OF ACCESS LINES
OF THE MEMORY ARRAY — 474

↓

SENSING A NUMBER OF MEMORY CELLS
COUPLED TO THE NUMBER OF ACCESS LINES — 476

↓

SENSING WHETHER THE VOLTAGE OF THE IO LINE
CHANGES IN RESPONSE TO ACTIVATION OF
SELECTED DECODE LINES CORRESPONDING
TO THE NUMBER OF MEMORY CELLS — 478

Fig. 4

APPARATUSES AND METHODS FOR PERFORMING COMPARE OPERATIONS USING SENSING CIRCUITRY

PRIORITY INFORMATION

This application is a Continuation of U.S. application Ser. No. 13/952,054, filed Jul. 26, 2013, the contents of which are incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates generally to semiconductor memory and methods, and more particularly, to apparatuses and methods related to performing compare operations using sensing circuitry.

BACKGROUND

Memory devices are typically provided as internal, semiconductor, integrated circuits in computers or other electronic systems. There are many different types of memory including volatile and non-volatile memory. Volatile memory can require power to maintain its data (e.g., host data, error data, etc.) and includes random access memory (RAM), dynamic random access memory (DRAM), static random access memory (SRAM), synchronous dynamic random access memory (SDRAM), and thyristor random access memory (TRAM), among others. Non-volatile memory can provide persistent data by retaining stored data when not powered and can include NAND flash memory, NOR flash memory, and resistance variable memory such as phase change random access memory (PCRAM), resistive random access memory (RRAM), and magnetoresistive random access memory (MRAM), such as spin torque transfer random access memory (STT RAM), among others.

Electronic systems often include a number of processing resources (e.g., one or more processors), which may retrieve and execute instructions and store the results of the executed instructions to a suitable location. A processor can comprise a number of functional units such as arithmetic logic unit (ALU) circuitry, floating point unit (FPU) circuitry, and/or a combinatorial logic block, for example, which can be used to execute instructions by performing logical operations such as AND, OR, NOT, NAND, NOR, and XOR logical operations on data (e.g., one or more operands). For example, the functional unit circuitry (FUC) may be used to perform arithmetic operations such as addition, subtraction, multiplication, and/or division on operands.

A number of components in an electronic system may be involved in providing instructions to the FUC for execution. The instructions may be generated, for instance, by a processing resource such as a controller and/or host processor. Data (e.g., the operands on which the instructions will be executed) may be stored in a memory array that is accessible by the FUC. The instructions and/or data may be retrieved from the memory array and sequenced and/or buffered before the FUC begins to execute instructions on the data. Furthermore, as different types of operations may be executed in one or multiple clock cycles through the FUC, intermediate results of the instructions and/or data may also be sequenced and/or buffered.

Executing instructions (e.g, as part of program execution) can involve performing operations such as compare operations and the results can be provided (e.g., reported) to the processing resources as part of the executional flow of an algorithm, for example. Such compare and report function-

ality can enable, for instance, "if-then-else" programmatic flow, which is often part of program execution.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an apparatus in the form of a computing system including a memory device in accordance with a number of embodiments of the present disclosure.

FIG. 2 illustrates a schematic diagram of a portion of a memory array coupled to sensing circuitry in accordance with a number of embodiments of the present disclosure.

FIG. 3 illustrates a schematic diagram of a portion of a memory array coupled to sensing circuitry in accordance with a number of embodiments of the present disclosure.

FIG. 4 illustrates an example of a method for performing a compare operation in accordance with a number of embodiments of the present disclosure.

DETAILED DESCRIPTION

The present disclosure includes apparatuses and methods related to performing compare operations using sensing circuitry. An example method comprises charging (e.g., precharging) an input/output (IO) line (e.g., a local IO (LIO line)) of a memory array to a pvoltage (e.g., a precharge voltage). The method can include determining whether data stored in the memory array matches a compare value by activating a number of access lines of the memory array and sensing a number of memory cells coupled to the number of access lines. The method can include sensing whether the voltage (e.g., precharge voltage) of the LIO line changes in response to activation of selected decode lines (e.g., column decode lines) corresponding to the number of memory cells. In the present disclosure, a "line" is meant to refer to an operable coupling between at least two nodes.

A number of embodiments of the present disclosure can provide benefits such as improved compare and report functionality in association with determining whether a match exists between a compare value (e.g., a particular data value and/or set of data values) and a data value stored in a memory array. For instance, a number of embodiments can provide for identifying whether particular data is stored in a number of memory cells without transferring data out of the memory array and sensing circuitry via a bus (e.g., data bus, address bus, control bus), for instance. The determination of whether data stored in the array matches the compare value can be reported, for instance, to control circuitry (e.g., to an on-die controller and/or to an external host). The determination of whether data stored in the array matches the compare value can be reported into the memory array. Such compare and report functionality can be associated with performing a number of logical operations (e.g., AND, NOT, NOR, NAND, XOR, etc.). However, embodiments are not limited to these examples.

Also, circuitry such as FUC associated with various processing resource(s) may not conform to pitch rules associated with a memory array. For example, the cells of a memory array may have a $4F^2$ or $6F^2$ cell size, where "F" is a feature size corresponding to the cells. The devices (e.g., logic gates) associated with FUC of previous systems may not be capable of being formed on pitch with the memory cells, which can affect chip size and/or memory density, for example.

In the following detailed description of the present disclosure, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of

illustration how one or more embodiments of the disclosure may be practiced. These embodiments are described in sufficient detail to enable those of ordinary skill in the art to practice the embodiments of this disclosure, and it is to be understood that other embodiments may be utilized and that process, electrical, and/or structural changes may be made without departing from the scope of the present disclosure. As used herein, the designators "N," "P," "R," etc., particularly with respect to reference numerals in the drawings, can indicate that a number of the particular features so designated can be included. As used herein, "a number of" a particular thing can refer to one or more of such things (e.g., a number of memory arrays can refer to one or more memory arrays).

The figures herein follow a numbering convention in which the first digit or digits correspond to the drawing figure number and the remaining digits identify an element or component in the drawing. Similar elements or components between different figures may be identified by the use of similar digits. For example, 130 may reference element "30" in FIG. 1, and a similar element may be referenced as 230 in FIG. 2. As will be appreciated, elements shown in the various embodiments herein can be added, exchanged, and/or eliminated so as to provide a number of additional embodiments of the present disclosure. In addition, as will be appreciated, the proportion and the relative scale of the elements provided in the figures are intended to illustrate certain embodiments of the present invention, and should not be taken in a limiting sense.

FIG. 1 is a block diagram of an apparatus in the form of a computing system 100 including a memory device 120 in accordance with a number of embodiments of the present disclosure. As used herein, a memory device 120, a memory array 130, and/or sensing circuitry 150 might also be separately considered an "apparatus."

System 100 includes a host 110 coupled to memory device 120, which includes a memory array 130. Host 110 can be a host system such as a personal laptop computer, a desktop computer, a digital camera, a mobile telephone, or a memory card reader, among various other types of hosts. Host 110 can include a system motherboard and/or backplane and can include a number of processing resources (e.g., one or more processors, microprocessors, or some other type of controlling circuitry). The system 100 can include separate integrated circuits or both the host 110 and the memory device 120 can be on the same integrated circuit. The system 100 can be, for instance, a server system and/or a high performance computing (HPC) system and/or a portion thereof. Although the example shown in FIG. 1 illustrates a system having a Von Neumann architecture, embodiments of the present disclosure can be implemented in non-Von Neumann architectures (e.g., a Turing machine), which may not include one or more components (e.g., CPU, ALU, etc.) often associated with a Von Neumann architecture.

For clarity, the system 100 has been simplified to focus on features with particular relevance to the present disclosure. The memory array 130 can be a DRAM array, SRAM array, STT RAM array, PCRAM array, TRAM array, RRAM array, NAND flash array, and/or NOR flash array, for instance. The array 130 can comprise memory cells arranged in rows coupled by access lines (which may be referred to herein as row lines, word lines or select lines) and columns coupled by sense lines (which may be referred to herein as digit lines or data lines). Although a single array 130 is shown in FIG. 1, embodiments are not so limited. For instance, memory device 120 may include a number of arrays 130 (e.g., a

number of banks of DRAM cells). An example DRAM array is described in association with FIGS. 2 and 3.

The memory device 120 includes address circuitry 142 to latch address signals provided over an I/O bus 156 (e.g., a data bus) through I/O circuitry 144. Address signals are received and decoded by a row decoder 146 and a column decoder 152 to access the memory array 130. Data can be read from memory array 130 by sensing voltage and/or current changes on the sense lines using sensing circuitry 150. The sensing circuitry 150 can read and latch a page (e.g., row) of data from the memory array 130. The I/O circuitry 144 can be used for bi-directional data communication with host 110 over the I/O bus 156. The write circuitry 148 is used to write data to the memory array 130.

Control circuitry 140 decodes signals provided by control bus 154 from the host 110. These signals can include chip enable signals, write enable signals, and address latch signals that are used to control operations performed on the memory array 130, including data read, data write, and data erase operations. In various embodiments, the control circuitry 140 is responsible for executing instructions from the host 110. The control circuitry 140 can be a state machine, a sequencer, or some other type of controller (e.g., an on-die controller).

An example of the sensing circuitry 150 is described further below in association with FIGS. 2 and 3. For instance, in a number of embodiments, the sensing circuitry 150 can comprise a number of sense amplifiers (e.g., sense amplifiers 206-1, . . . , 206-P shown in FIG. 2 or sense amplifier 306 shown in FIG. 3) and a number of compute components (e.g., compute component 331 shown in FIG. 3), which may comprise an accumulator and can be used to perform compare and report operations (e.g., on data associated with complementary sense lines). In a number of embodiments, the sensing circuitry (e.g., 150) can be used to perform compare and report operations using data stored in array 130 as inputs and store the results of the logical operations back to the array 130 without transferring via a sense line address access (e.g., without firing a column decode signal). As such, various compute functions can be performed within array 130 using sensing circuitry 150 rather than being performed by processing resources external to the sensing circuitry (e.g., by a processor associated with host 110 and/or other processing circuitry, such as ALU circuitry, located on device 120 (e.g., on control circuitry 140 or elsewhere)). In various previous approaches, data associated with an operand, for instance, would be read from memory via sensing circuitry and provided to external ALU circuitry via local I/O lines. The external ALU circuitry would perform compute functions using the operands and the result would be transferred back to the array via the local I/O lines. In contrast, in a number of embodiments of the present disclosure, sensing circuitry (e.g., 150) can be configured to perform logical operations on data stored in memory (e.g., array 130) and store the result to the memory without enabling a local I/O line coupled to the sensing circuitry.

FIG. 2 illustrates a schematic diagram of a portion of a memory array coupled to sensing circuitry in accordance with a number of embodiments of the present disclosure. In this example, the memory array is a DRAM array of memory cells (MCs) 260-1, . . . , 260-N. In a number of embodiments, the memory cells are destructive read memory cells (e.g., reading the data stored in the cell destroys the data such that the data originally stored in the cell is refreshed after being read). The memory cells 260-1, . . . , 260-N of the array in FIG. 2 can be arranged in

a number of rows coupled by word line **204** and columns coupled by sense lines (e.g., digit lines) **205-1**, . . . , **205-M**. For ease of reference, the sense lines **205-1**, . . . , **205-M** represent respective pairs of complementary sense lines (e.g., **305-1** and **305-2** in FIG. **3**). Although only one row and two columns of memory cells are illustrated in FIG. **2**, embodiments are not so limited. For instance, a particular array may have a number of columns of memory cells and/or sense lines (e.g., 4,096, 8,192, 16,384, etc.). As an example, a gate of a particular memory cell transistor (e.g., **302** in FIG. **3**) can be coupled to its corresponding word line (**204**), a source/drain region can be coupled to its corresponding sense line (e.g., **205-1**), and a second source/drain region of a particular memory cell transistor can be coupled to its corresponding capacitor (e.g., **303** in FIG. **3**).

The array in FIG. **2** can be coupled to sensing circuitry in accordance with a number of embodiments of the present disclosure. In this example, the sensing circuitry comprises sense amplifiers **206-1**, . . . , **206-P** and secondary sense amplifier (SSA) **268**. The sensing circuitry can be sensing circuitry **150** shown in FIG. **1**. The sense amplifiers **206-1** to **206-P** are coupled to the respective sense lines **205-1** to **205-M**. The sense amplifiers **206-1** to **206-P** can be sense amplifiers such as sense amplifier **306** described below in association with FIG. **3**. The sense amplifiers **206-1** to **206-P** are coupled to input/output lines **266-1** (IO) and **266-2** (IO_) via transistors **218-1** and **218-2**, respectively. Column decode lines **264-1** (CD-1) to **264-R** (CD-R) are coupled to the gates of transistors **218-1** and **218-2** and can be selectively activated to transfer data sensed by respective sense amps **206-1** to **206-P** to the SSA **268** via IO lines **266-1** and **266-2**

In operation, sense amps (e.g., **206-1** to **206-P**) can sense a data value (e.g., a logic "1" or "0") stored in a memory cell (e.g., **260-1** to **260-N**) by amplifying a differential signal (e.g., voltage or current) on the complementary sense lines (e.g., **205-1** to **205-M**) responsive to activation of a selected row line (e.g., **204**). As an example, the sense amps **206-1** to **206-P** can drive one of the sense lines (e.g., D) of the pair of complementary sense lines **205-1** to a first value (e.g., to a supply voltage such as Vcc), and the other sense line (D_) of the pair of complementary sense lines **205-1** to a second value (e.g., to a reference voltage such as a ground voltage). In this manner, the data value stored by the memory cell (e.g., **260-1**) can be determined based on which of the sense lines of the complementary sense line pair is driven to Vcc, for instance. The voltages of the complementary sense line pairs **205-1** to **205-M** can then be selectively transferred to the IO lines **266-1** and **266-2** via activation of the column decode lines **264-1** to **264-R**. In this manner, the data sensed by the sense amps **206-1** to **206-P** can be transferred to the SSA **268** via IO lines **266-1** and **266-2**. Often, the SSA **268** may only be capable of storing a data value from a single cell (e.g., one of cells **260-1** to **260-N**) at a particular time. As such, if it is desired to transfer the data stored in cell **260-1** to the SSA **268**, then column decode line **264-1** would be activated, and if it is desired to transfer the data stored in cell **260-N** to the SSA **268**, then column decode **264-R** would be activated. If both lines **264-1** and **264-R** were activated, the SSA **268** may not be able to determine the actual stored data values stored in either of the cells.

However, in various instances, it can be useful to selectively activate more than one of the column decode lines (e.g., **264-1** to **264-R**). For example, selectively activating a number of column decode lines can be done in association with performing a compare operation in accordance with a number of embodiments described herein. For instance, in a

number of embodiments of the present disclosure, the data path portion shown in FIG. **2** can be operated to determine whether data stored in a memory array (e.g., array **130**) matches a compare value, which may be provided by an on-die control circuit (e.g., control circuitry **140**) and/or by external control circuitry (e.g., host **110**) as part of an "if-then-else" programmatic flow, for example.

In a number of embodiments, control circuitry (e.g., **140** in FIG. **1**) can be configured to charge (.e.g., precharge) an IO line (e.g., **266-1**) to a voltage (e.g., a precharge voltage). For example, the IO line **266-1** can be precharged to a voltage (e.g., a supply voltage such as Vcc) corresponding to a logic "1." The control circuitry can be configured to selectively activate row lines (e.g., a row line including memory cells **260-1**, . . . , **260-N**) and column decode lines (e.g., CD-**1**, . . . , CD-R). Sensing circuitry (e.g., **150** in FIG. **1**) can be configured to sense a number of selected memory cells (e.g., **260-1**, . . . , **260-N**) coupled to an activated row line. The sensing circuitry can be configured to determine whether the precharge voltage of the IO line **266-1** changes in response to selective activation of column decode lines CD-**1** to CD-R.

In a number of embodiments, the control circuitry (e.g., **140** in FIG. **1**) can, in conjunction with the sensing circuitry, can be used to perform a compare function (e.g., to determine if data stored in the memory array matches a compare value). As an example, the IO line **266-1** can be precharged to a particular voltage. The particular voltage can be a voltage corresponding to a data value. For instance the precharge voltage can be a supply voltage such as Vcc, which may correspond to a logic "1," or a ground voltage, which may correspond to a logic "0."

Activation of column decode line CD-**1** turns on transistors **218-1** and **218-2**, which provides voltages corresponding to the data stored in sense amp **206-1** to IO lines **266-1** and **266-2**. As such, the precharge voltage of IO line **266-1** can change based on the particular data value stored in sense amp **206-1** (which represents the data stored in a particular memory cell such as cell **260-1**). For example, if the sense amplifier **206-1** senses a logic 0 (e.g., a ground voltage) stored in cell **260-1**, then the precharge voltage (e.g., Vcc) on the IO line **266-1** will be pulled down (e.g., lowered) when CD-**1** is activated, and the change in the precharge voltage change can be detected by the SSA **268**. As such, the detected change in the precharge voltage indicates that the sensed memory cell (e.g., **260-1**) stores a data value (e.g., 0) different from the data value (e.g., 1) corresponding to the precharge voltage. Similarly, if the sense amplifier **206-1** senses a logic 1 (e.g., Vcc) stored in cell **260-1**, then the precharge voltage (e.g., Vcc) on the IO line **266-1** will not be pulled down when CD-**1** is activated, and no change in the precharge voltage will be detected by the SSA **268**. As such, no detected change in the precharge voltage indicates that the sensed memory cell (e.g., **260-1**) stores the same data value (e.g., 1) as the data value (e.g., 1) corresponding to the precharge voltage.

The above described ability of the SSA **268** to determine whether the precharge voltage changes can be used to perform compare functions to determine whether a particular compare value matches data stored in a memory array, for instance. As an example, if an operation requires knowledge of whether a number of cells coupled to a particular row line stores a particular compare value (e.g., 0), the particular row line can be activated along with the sense lines corresponding the number of memory cells. If any of the cells store a 0, then the precharge voltage of the IO line (e.g., local IO line) will be changed (e.g., pulled down). The result of the

operation can be reported, for instance, to the requesting control circuitry (e.g., on-die controller, host, etc.). The result of the operation can be reported into the memory array for further calculations. The determined result may be used as part of continued execution of a particular algorithm. For instance, execution may include not only determining if any of the memory cells of the row store a data value (e.g., 0), but which cell(s) store the data value. As such, subsets of the column decode lines may be selectively activated to compare the data values stored by their corresponding cells to the compare value, which can be used in association with binary searching, for instance.

The compare values used in association with compare operations can be requested by control circuitry coupled to the sense circuitry (e.g., on-die controller) and/or by a number of other sources such as an external host, for instance. Similarly, results of compare operations can be reported to various control circuitry and/or used to perform further operations (e.g., logic operations) as part of if-then-else programmatic flow prior to being reported to control circuitry.

FIG. 3 illustrates a schematic diagram of a portion of a memory array 330 coupled to sensing circuitry in accordance with a number of embodiments of the present disclosure. In this example, the memory array 330 is a DRAM array of 1T1C (one transistor one capacitor) memory cells each comprised of an access device 302 (e.g., transistor) and a storage element 303 (e.g., a capacitor). In a number of embodiments, the memory cells are destructive read memory cells (e.g., reading the data stored in the cell destroys the data such that the data originally stored in the cell is refreshed after being read). The cells of array 330 are arranged in rows coupled by word lines 304-0 (Row0), 304-1 (Row1), 304-2, (Row2) 304-3 (Row3), . . . , 304-N (RowN) and columns coupled by sense lines (e.g., digit lines) 305-1 (D) and 305-2 (D_). In this example, each column of cells is associated with a pair of complementary sense lines 305-1 (D) and 305-2 (D_). Although only a single column of memory cells is illustrated in FIG. 3, embodiments are not so limited. For instance, a particular array may have a number of columns of memory cells and/or sense lines (e.g., 4,096, 8,192, 16,384, etc.). A gate of a particular memory cell transistor 302 is coupled to its corresponding word line 304-0, 304-1, 304-2, 304-3, . . . , 304-N, a first source/drain region is coupled to its corresponding sense line 305-1, and a second source/drain region of a particular memory cell transistor is coupled to its corresponding capacitor 303. Although not illustrated in FIG. 3, the sense line 305-2 may also be coupled to a column of memory cells.

The array 330 is coupled to sensing circuitry in accordance with a number of embodiments of the present disclosure. In this example, the sensing circuitry comprises a sense amplifier 306 and a compute component 331. The sensing circuitry can be sensing circuitry 150 shown in FIG. 1. The sense amplifier 306 is coupled to the complementary sense lines D, D_ corresponding to a particular column of memory cells. The sense amp 306 can be operated to determine a state (e.g., logic data value) stored in a selected cell. Embodiments are not limited to the example sense amplifier 306. For instance, sensing circuitry in accordance with a number of embodiments described herein can include current-mode sense amplifiers and/or single-ended sense amplifiers (e.g., sense amplifiers coupled to one sense line).

In a number of embodiments, a compute component (e.g., 331) can comprise a number of transistors formed on pitch with the transistors of the sense amp (e.g., 306) and/or the

memory cells of the array (e.g., 330), which may conform to a particular feature size (e.g., $4F^2$, $6F^2$, etc.). As described further below, the compute component 331 can, in conjunction with the sense amp 306, operate to perform various compare and report operations using data from array 330 as input and store the result back to the array 330 without transferring the data via a sense line address access (e.g., without firing a column decode signal such that data is transferred to circuitry external from the array and sensing circuitry via local I/O lines (e.g., 266-1 in FIG. 2).

In the example illustrated in FIG. 3, the circuitry corresponding to compute component 331 comprises five transistors coupled to each of the sense lines D and D_; however, embodiments are not limited to this example. Transistors 307-1 and 307-2 have a first source/drain region coupled to sense lines D and D_, respectively, and a second source/drain region coupled to a cross coupled latch (e.g., coupled to gates of a pair of cross coupled transistors, such as cross coupled NMOS transistors 308-1 and 308-2 and cross coupled PMOS transistors 309-1 and 309-2. As described further herein, the cross coupled latch comprising transistors 308-1,308-2, 309-1, and 309-2 can be referred to as a secondary latch (the cross coupled latch corresponding to sense amp 306 can be referred to herein as a primary latch).

The transistors 307-1 and 307-2 can be referred to as pass transistors, which can be enabled via respective signals 311-1 (Passd) and 311-2 (Passdb) in order to pass the voltages or currents on the respective sense lines D and D_ to the inputs of the cross coupled latch comprising transistors 308-1, 308-2, 309-1, and 309-2 (e.g., the input of the secondary latch). In this example, the second source/drain region of transistor 307-1 is coupled to a first source/drain region of transistors 308-1 and 309-1 as well as to the gates of transistors 308-2 and 309-2. Similarly, the second source/drain region of transistor 307-2 is coupled to a first source/drain region of transistors 308-2 and 309-2 as well as to the gates of transistors 308-1 and 309-1.

A second source/drain region of transistor 308-1 and 308-2 is commonly coupled to a negative control signal 312-1 (Accumb). A second source/drain region of transistors 309-1 and 309-2 is commonly coupled to a positive control signal 312-2 (Accum). The Accum signal 312-2 can be a supply voltage (e.g., Vcc) and the Accumb signal can be a reference voltage (e.g., ground). Enabling signals 312-1 and 312-2 activates the cross coupled latch comprising transistors 308-1, 308-2, 309-1, and 309-2 corresponding to the secondary latch. The activated sense amp pair operates to amplify a differential voltage between common node 317-1 and common node 317-2 such that node 317-1 is driven to one of the Accum signal voltage and the Accumb signal voltage (e.g., to one of Vcc and ground), and node 317-2 is driven to the other of the Accum signal voltage and the Accumb signal voltage. As described further below, the signals 312-1 and 312-2 are labeled "Accum" and "Accumb" because the secondary latch can serve as an accumulator while being used to perform a logical operation. In a number of embodiments, an accumulator comprises the cross coupled transistors 308-1, 308-2, 309-1, and 309-2 forming the secondary latch as well as the pass transistors 307-1 and 308-2. As described further herein, in a number of embodiments, a compute component comprising an accumulator coupled to a sense amplifier can be configured to perform a logical operation that comprises performing an accumulate operation on a data value represented by a signal (e.g., voltage or current) on at least one of a pair of complementary sense lines.

The compute component **331** also includes inverting transistors **314-1** and **314-2** having a first source/drain region coupled to the respective digit lines D and D_. A second source/drain region of the transistors **314-1** and **314-2** is coupled to a first source/drain region of transistors **316-1** and **316-2**, respectively. The gates of transistors **314-1** and **314-2** are coupled to a signal **313** (InvD). The gate of transistor **316-1** is coupled to the common node **317-1** to which the gate of transistor **308-2**, the gate of transistor **309-2**, and the first source/drain region of transistor **308-1** are also coupled. In a complementary fashion, the gate of transistor **316-2** is coupled to the common node **317-2** to which the gate of transistor **308-1**, the gate of transistor **309-1**, and the first source/drain region of transistor **308-2** are also coupled. As such, enabling signal InvD serves to invert the data value stored in the secondary latch and drives the inverted value onto sense lines **305-1** and **305-2**.

In a number of embodiments of the present disclosure, a compare operation can include activating a row of memory cells (e.g., row line **204**) to determine if there is a match in the row line (e.g., at least one memory cell stores a compare value). A compare operation can be expanded to include comparing a 32-bit compare value to data stored in the array. For example, compare values of a number of memory cells can be aggregated in an accumulator (as described above) to determine if there is a collection of compare values that match a 32-bit compare value.

Embodiments of the present disclosure are not limited to the particular sensing circuitry configuration illustrated in FIGS. **2** and **3**. For instance, different compute component circuitry can be used to perform logical operations in accordance with a number of embodiments described herein.

FIG. **4** illustrates an example of a method for performing a compare operation in accordance with a number of embodiments of the present disclosure. At block **470**, the method includes precharging an input/output (IO) line (e.g., **266-1** in FIG. **2**) of a memory array (e.g., **330** in FIG. **3**) to a precharge voltage. The IO line (e.g., a local IO line) can be precharged, for instance, to a voltage corresponding to a particular data value, such as a supply voltage (e.g., Vcc corresponding to logic 1) or a reference voltage (e.g., a ground voltage corresponding to logic 0). A number of embodiments can include precharging a LIO_line (e.g., **266-2** in FIG. **2**) of a memory array to a precharge voltage. The voltage to which the LIO_line is precharged can be an inverse of a voltage to which the LIO line is precharged.

At block **472**, the method includes determining whether data stored in the memory array matches a compare value. The compare value can be a value provided by an external host (e.g., an external processor) and/or an on die controller. The compare value can include a number of different data values that the control circuitry is attempting to determine whether are stored in at least one memory cell in a memory array. The compare value can be stored in a number of memory cells. For example, the data can be stored in one, two, three, etc., memory cells. A match can refer to a determination that a compare value provided by the control circuitry is stored in at least one memory cell of the array. A determination that the compare value is not stored in at least one memory cell can indicate that there is not a match.

The determination of whether data stored in the memory array matches a compare value can be determined, at block **474**, by activating a number of row lines of the memory array. The number of row lines can be selectively activated based on a characteristic of the row lines. The number of row lines can include particular row lines that are predetermined by a controller (e.g., an external host, an on-die controller).

The determination of whether data stored in the memory array matches a compare value can be determined, at block **476**, by sensing a number of memory cells coupled to the number of row lines. The voltage of the memory cells of the row lines of the memory array can be sensed by the sense amplifiers and column decode lines can be activated to provide the voltage of the sense amplifiers (and corresponding memory cells) to the LIO line.

The determination of whether data stored in the memory array matches a compare value can be determined, at block **478**, by sensing whether the precharge voltage of the LIO line changes in response to activation of selected column decode lines corresponding to the number of memory cells. For example, the LIO line can be precharged to a supply voltage (e.g., Vcc) corresponding to a logic 1. A memory cell in the memory array may store a data value (e.g., logic 0) corresponding to a compare value that a controller is trying to locate (e.g., match). When the memory cell is activated and the voltage of the cell is provided to the LIO line (e.g., via the corresponding sense amp), the voltage on the LIO line (e.g., precharge voltage) will drop if the data value stored by the cell matches the compare value (e.g., if the data value stored by the cell is a logic 0). The secondary sense amplifier can detect the drop in voltage and determine that a match has occurred. The determination of the match can be reported to circuitry that provided the compare value (e.g., an on die controller, an external host, etc.) and/or to some other control circuitry for further use. If a match is determined, further operations can be performed to determine a particular location (e.g., cell or cells) within the array where the match occurs. Peripheral control logic can read a data path to determine the compare state of the memory array. Locating the match can include a search method (e.g., a binary search) to determine which memory cell in the memory array matched. The match can occur at a number of memory cells (e.g, no memory cell, one memory cell, or a plurality of memory cells).

Although specific embodiments have been illustrated and described herein, those of ordinary skill in the art will appreciate that an arrangement calculated to achieve the same results can be substituted for the specific embodiments shown. This disclosure is intended to cover adaptations or variations of one or more embodiments of the present disclosure. It is to be understood that the above description has been made in an illustrative fashion, and not a restrictive one. Combination of the above embodiments, and other embodiments not specifically described herein will be apparent to those of skill in the art upon reviewing the above description. The scope of the one or more embodiments of the present disclosure includes other applications in which the above structures and methods are used. Therefore, the scope of one or more embodiments of the present disclosure should be determined with reference to the appended claims, along with the full range of equivalents to which such claims are entitled.

In the foregoing Detailed Description, some features are grouped together in a single embodiment for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the disclosed embodiments of the present disclosure have to use more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate embodiment.

What is claimed:

1. A method, comprising:

charging an input/output (IO) line of a memory array to a voltage;

activating an access line of the memory array and at least two selected decode lines of the array at the same time; and

determining whether at least one memory cell coupled to the access line stores a compare value by sensing whether the voltage of the IO line changes in response to the activation of the at least two selected decode lines.

2. The method of claim 1, wherein charging an IO line includes precharging an IO line of the memory array to a precharge voltage.

3. The method of claim 1, wherein charging the IO line to the voltage includes charging the IO line to a supply voltage.

4. The method of claim 3, wherein the supply voltage corresponds to a particular data value.

5. The method of claim 1, wherein charging the IO line to a voltage includes charging the IO line to a ground voltage.

6. The method of claim 5, wherein the ground voltage corresponds to a particular data value.

7. The method of claim 1, wherein activating selected decode lines comprises activating a subset of the decode lines of the array.

8. The method of claim 7, including determining the subset of decode lines based on a set of criteria of the subset.

9. An apparatus comprising:

an array of memory cells;

a controller configured to cause:

  precharging of an input/output (IO) line of the array to a precharge voltage;

  selective activation of an access line of the array; and

  selective activation of at least two decode lines of the array at the same time; and

sensing circuitry coupled to the array and configured to:

  sense a number of selected memory cells coupled to the activated access line; and

  determine whether the precharge voltage of the IO line changes in response to the activation of the at least two decode lines.

10. The apparatus of claim 9, wherein the controller comprises an on die controller.

11. The apparatus of claim 9, wherein the controller comprises an external host.

12. The apparatus of claim 9, wherein the precharge voltage corresponds to a particular data value and a determined change in the precharge voltage of the IO line indicates that a selected memory cell corresponding to an activated decode line of the decode lines stores a data value other than the particular data value.

13. The apparatus of claim 9, wherein the sensing circuitry comprises a secondary sense amp configured to detect whether the precharge voltage of the IO line changes.

14. The apparatus of claim 9, wherein a determined change in the precharge voltage of the IO line indicates data in a memory cell matches a compare value.

15. The apparatus of claim 9, wherein the control circuitry is configured to report a determined change in the precharge voltage of the IO line to a host.

16. The apparatus of claim 9, wherein the sensing circuitry is configured to provide an indication that a determined change in the precharge voltage of the IO line was detected.

17. An apparatus comprising:

an array of memory cells;

control circuitry configured to cause:

  charging of an input/output (IO) line of the memory array to a voltage;

  selective activation of a plurality of access lines at the same time; and

  selective activation of at least two decode lines at the same time; and

sensing circuitry coupled to the memory array and configured to determine whether the charged voltage of the IO line changes in response to activation of the at least two decode lines.

18. The apparatus of claim 17, wherein:

charging an IO line to a voltage includes precharging an IO line of the memory array to a precharge voltage; and

a determined change in the precharge voltage of the IO line indicates that at least one memory cell of memory cells coupled to the access lines matches a compare value.

19. The apparatus of claim 17, wherein the sensing circuitry comprises a number of accumulators coupled to a respective number of primary sense amplifiers.

20. The apparatus of claim 17, wherein the sensing circuitry configured to determine whether the charged voltage of the IO line changes comprises a secondary sense amplifier coupled to the IO line.

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